hours. Near Mount Whitney, on its eastern slope, 2 inches fell, September 5 and 6, above 12,000 feet. On the 28th also 2 inches fell.

SUNSHINE.

The following table gives the total hours of sunshine and percentages of the possible:

Stations.	Hours.	Percentage of possible.	Stations.	Hours.	Percentage of possible
Eureka	112	30	Sacramento	330	89
Fresno	348	93	San Diego	278	75
Los Angeles	287	71	San Francisco	243	65
Mount Tamalpais	271	73	San Jose	293	79
Red Bluff	313	84	San Luis Obispo	276	74

NOTES ON THE RIVERS OF THE SACRAMENTO AND LOWER SAN JOAQUIN WATERSHEDS DURING SEPTEMBER, 1912.

By N. R. TAYLOR, Local Forecaster.

Sacramento watershed.—All streams in this watershed averaged slightly above the stages that obtained during the preceding month. They were, however, abnormally low, especially the Sacramento River between Walnut Grove and the mouth of the Feather, which was lower than for any previous September of which there is a record.

General rains throughout the drainage basin of the Sacramento Valley during the first decade of the month resulted in rapid rises in the main rivers and freshets in some of the smaller watercourses. The greatest 24-hour rise in the Sacramento was at Colusa, where it rose 6.7 feet and culminated in a stage of 11.2 feet on the 8th. The crest of this rise reached Sacramento city on the 9th. After this date the river fell steadily.

In the watershed of the Feather-Yuba River there was a substantial rise during the three days ending on the 9th, but after this date both streams fell rapidly, and by the end of the month they had reached the extreme low-water stages that prevailed prior to the rains.

In the American River watershed the rainfall was lighter than in any other section of the valley, and as a result there was little change in the run-off of this stream.

There was a marked improvement in the navigability of the Sacramento River as a result of the rise, which swept away many of the sand bars that had formed at various points in this stream.

San Joaquin watershed.—The rivers of this watershed averaged about 0.5 of a foot above their height during the preceding month, due to the rains that were more or less general in the first decade of the month. The rises, however, were slight, the greatest being 1 foot in the Tuolumne River at Jacksonville during the 24 hours ending at 7 a. m. of the 8th.

NOTES ON STREAMS AND WEATHER OF THE UPPER SAN JOAQUIN WATERSHED.

By W. E. BONNETT, Local Forecaster.

Although low, the mean stages of the streams of this district for September were higher than the stages for that month in several other years of the last six and in some cases higher even than the September average for that period.

At Merced Falls the mean stage was 0.3 foot, equalling the 1911 stage and exceeding the September stages in the years 1907 to 1910, inclusive. Daily gage heights were very uniform throughout the month, with a range of but 0.2 foot. In the San Joaquin the average monthly stage at Firebaugh was −0.5 foot, or slightly lower than the 6-year mean, and higher than the stages in 1908, 1909, and 1910.

On the whole, weather conditions were favorable. A fall of 0.10 inch of rain occurred on the 3d, making the third date in 26 years on which there has been measurable rainfall between August 1 and September 3. The temperature was about one degree below normal. The first decade was so cool that the high temperature during the remainder of the month did not overcome the negative departure.

EXCESSIVE RAINS IN CALIFORNIA.

By A. G. MCADIE.

In an article in the Monthly Weather Review, July, 1912, page 1062, Mr. Edward D. Coberly gives an extensive tabulation of all monthly rainfalls of 10 inches or more and of all amounts of 4 inches or more in 24 hours that have occurred in the State of Louisiana. It has occurred to the writer that a somewhat similar table for California would be of value not only for engineers and others interested in power questions, but also for students of climatology who may be interested in studies of heavy rainfall in various parts of the United States.

It is evident from the figures that follow that certain portions of California may well be considered as lying within the zone of maximum intensity of rainfall in the United States. It may also be noted that the records are of comparatively recent date and have been made with standard 8-inch gages properly exposed.

The following table shows the heaviest recorded rainfall in California during the past 10 years: The greatest annual amount is 153.54 inches (3,900 mm.) at Monumental, Del Norte County, exact elevation not determined. This occurred in 1909. This is not given in the list compiled by Mr. Coberly, although in excess of any of the rainfalls quoted for places in the United States, except Glenora, Oreg., record of 1896, when 167.29 inches (4,250 mm.) fell, and the same place in 1897, 156.50 inches (3,969 mm.) fell.

Rainfalls exceeding 100 inches (2,540 mm.) have occurred at many points in California. From an inspection of long period records made at several stations in California, we are justified in concluding that the year 1909 in California was the year of heaviest rainfall. The years 1871, 1879, 1880, 1882, 1884, 1893, 1896, 1899, 1904, 1907, and 1911 were all years of heavy rainfall; but it is doubtful if the total amount at any one station was in excess of that which fell during 1909.

Excessive annual rainfalls in California.

Stations.	Elevation.	1911.	1910.	1909.	1908.	1907.	1906.	1905.	1904.	1903.	1902.
	Feet.										
Monumental	.....	.....	.....	153.54	88.59	139.20	116.13	69.30	.....	.....	.....
Magalia	2,321	77.62	49.32	150.62	44.96	96.32	125.01	48.16	94.40	.....	.....
La Porte	5,000	.....	60.22	141.40	58.08	113.94	124.46	.....	.....	77.04	89.09
Helen Mine	2,750	73.81	50.76	136.86	53.90	103.13	129.69	68.03	114.72	67.37	137.58
Inskip	4,975	78.49	58.08	134.18	56.42	.....	.....	.....	.....	.....	.....
Branscomb	2,000	65.17	56.49	130.14	59.06	108.42	99.08	55.03	115.07	91.06	120.35
Woodleaf	3,250	.....	.....	125.28	.....	103.18	125.41	.....	.....	.....	.....
Fordyce Dam	6,500	71.03	47.41	125.28	41.88	86.14	120.64	43.16	75.69	63.31	65.59
Bear Valley (Nevada Co.)	4,600	72.75	49.44	119.39	45.47	94.47	110.85	46.93	103.59	67.44	.....
Pilot Creek	4,000	79.94	44.01	113.98	41.96	87.15	110.61	42.56	93.99	68.66	60.70
Blue Canon	4,695	67.27	42.13	110.72	40.97	100.17	104.21	46.65	93.48	64.18	64.99
Stirling City	3,525	66.20	35.75	108.63	33.56	111.20	125.08	44.02	.....	.....	.....
Brush Creek	2,140	66.53	37.62	104.65	48.57	86.64	106.25	50.63	91.98	.....	.....
Nimshew	2,500	65.70	40.36	103.26	44.82	82.21	104.00	43.11	.....	.....	.....
Crescent City	50	.....	.....	.....	53.35	91.46	70.27	50.91	107.61	80.76	103.12
Upper Mattole	244	64.13	62.81	121.79	61.93	99.84	85.70	70.04	126.53	94.88	123.26
Bowmans Dam	5,500	.....	.....	113.85	47.27	86.55	97.45	64.49	135.70	88.70	70.92

Other heavy annual rainfalls were:

	Inches.
During 1909:	
Camptonville	136.38
Deer Creek	123.31
Delta	114.85
Downieville	101.64
Head Dam	100.14
Kennett	115.92
West Branch	119.45
During 1884, Bowmans Dam	119.64
During 1889:	
Delta	111.05
Upper Mattole	101.25
During 1890, Bowmans Dam	102.88
During 1896:	
Bowmans Dam	109.94
Bear Valley	102.34
Delta	100.27
La Porte	120.20
Upper Mattole	102.52
During 1899, La Porte	101.04

HEAVIEST MONTHLY RAINFALLS IN CALIFORNIA.

Apparently the heaviest monthly rainfall in the United States occurred in California, at Helen Mine, January, 1909, when 71.54 inches (1,817 mm.) fell. The following table shows excessive monthly amounts at a number of stations in California during January, 1909:

Stations.	Inches.	Stations.	Inches.
Bear Valley (Nevada County)	49.02	Helen Mine	71.54
Ben Lomond	42.57	Kennett	54.08
Blue Canon	48.35	La Porte	63.52
Boulder Creek	39.42	Laytonville	46.50
Bowmans Dam	47.53	Magalia	64.77
Branscomb	55.79	Monumental	43.84
Brush Creek	46.39	Mount St. Helena	40.33
Camptonville	55.43	Pilot Creek	50.25
Deer Creek	56.32	Stirling City	51.63
Delta	53.28	Upper Mattole	47.84
Downieville	42.81	Woodleaf	63.08
Fordyce Dam	55.53	West Branch	63.71
Head Dam	41.03		

The heaviest monthly rainfalls at regular Weather Bureau stations during entire period of record are:

	Inches.
San Francisco, January, 1862	24.36
Sacramento, January, 1862	15.04
Eureka, February, 1902	19.49
Red Bluff, November, 1885	17.05
Los Angeles, December, 1889	15.80
San Diego, February, 1884	9.05
Independence, December, 1867	12.19
San Luis Obispo, January, 1909	17.00
Mount Tamalpais, January, 1909	15.63
Point Reyes, January, 1909	9.78
San Jose, December, 1890	10.55
Fresno, December, 1909	4.50
Southeast Farallon, January, 1909	8.18

HEAVIEST 24-HOUR RAINFALLS.

While the record for maximum monthly rainfalls apparently lies with California, the record for the greatest 24-hour rainfall in the United States is probably that mentioned by Mr. Coberly, 21.4 inches, at Alexandria, La., June 15–16, 1886. In this connection, it is interesting to refer to the rainfall record made at Baguio, P. I., July 14 to 15, 1911, published as plate 5, of the Manila Weather Bureau Bulletin for July, 1911. The record made on a Friez quadruple register shows that the total rainfall from noon July 14 to noon 15 was 45.99 inches (1,168 mm.). The greatest hourly amounts were 3.60 inches (91 mm.) and 3.54 inches (90 mm.); the greatest rainfall in 10 minutes was 0.72 of an inch (18 mm.), and for five minutes, 0.40 of an inch (10 mm.). The total precipitation at Baguio for the four days, July 14 to 17, inclusive, was 88.85 inches (2,239 mm.). This is probably the finest and most reliable rainfall record that has yet been made during periods of excessive rain. In passing, it is interesting to note that the rainfall continued to be excessive for several days.

In California, the heaviest rainfall for a short period occurred at Campo, August 12, 1891. The 24-hour rainfall was 11.50 inches (292 mm.), so far as can be ascertained, and this fell practically within 80 minutes. The total amount for the storm, or cloudburst as it was known, was 16.10 inches (409 mm.). On March 12, 1906, at Mono Ranch, Ventura County, during a period of heavy rain, it was reported that 11.50 inches (292 mm.) fell in 24 hours. At Monumental 9.60 inches fell in 24 hours November 22, 1909; on the previous day 6.05 nches fell, and on the day following 2.80 inches.

Twenty-four hour rainfalls, 5 inches or more.

	Inches.
February, 1902:	
Ben Lomond	5.54
Branscomb	6.60
Calistoga	6.57
Delta	5.50
Healdsburg	5.65
Laurel	5.05
Mount St. Helena	7.00
Zenia	5.60
November, 1902:	
Branscomb	6.80
Mercury	5.06
January, 1903:	
Bowmans Dam	8.39
Crescent City	7.09
Shasta	5.04
Summerdale	6.44
Upper Mattole	5.30
March, 1903, Laurel	5.86
November, 1903:	
Branscomb	5.80
Colfax	5.02
Shasta	6.46
Upper Mattole	5.82
Ben Lomond	6.70
Boulder Creek	5.18
Brush Creek	5.72
Felton	5.59
Kentfield	6.27
Laurel	5.05
Nimshew	6.08
Pilot Creek	6.25
Pino Grande	8.00
Stirling City	6.00
February, 1904:	
Branscomb	7.85
La Porte	5.63
Mercury	6.88
Nevada City	5.56
Quincy	5.32
San Rafael	6.32
Shasta	6.58
Willits	5.77
Zenia	5.02
Bear Valley, Nevada County	6.00
Bowmans Dam	7.97
Kentfield	8.66
Laurel	5.90
Mount St. Helena	6.00
Pilot Creek	5.61
Upper Mattole	6.63
March, 1904:	
Brush Creek	5.13
Delta	5.01
Fort Ross	6.49
Healdsburg	5.25
Magalia	6.72
Mercury	5.47
Nimshew	5.50
Ben Lomond	7.02
Bowmans Dam	5.18
Mount St. Helena	6.00
Upper Mattole	5.21

	Inches.
December, 1904:	
Helen Mine	7.80
Meadow Valley	6.46
Mount St. Helena	5.75
January, 1905:	
Helen Mine	8.72
Mount St. Helena	6.20
Upper Mattole	6.21
February, 1905, Lowe Observatory	5.33
March, 1905:	
Nordhoff	5.75
Glenn Ranch	5.58
Lowe Observatory	6.00
Nellie	5.90
Ozena	6.78
January, 1906:	
Helen Mine	9.65
Magalia	10.86
Stirling City	8.50
Blocksburg	6.19
Branscomb	9.76
Brush Creek	6.70
Delta	6.00
Fort Ross	5.49
Georgetown	5.00
Greenville	5.40
La Porte	6.13
Monumental	6.53
Nimshew	5.70
Summerdale	7.10
Ukiah	5.20
Willits	7.70
Zenia	7.30
Bear Valley	5.08
Ben Lomond	5.18
Boulder Creek	5.93
Bowmans Dam	8.10
Fordyce Dam	6.50
Fouts Springs	5.01
Laurel	6.35
Laytonville	8.18
Mercury	6.80
Mount St. Helena	5.25
Nellie	6.24
Pilot Creek	7.39
Skyland	6.60
Upper Mattole	6.73
Woodleaf	6.85
March, 1906:	
Cuyamaca	7.48
Mono Ranch	11.50
Stirling City	5.20
Summerdale	6.08
Crockers	6.10
Glenn Ranch	6.57
Nellie	8.85
December, 1906:	
Brush Creek	5.33
Georgetown	5.88
Jamestown	5.50
Nevada City	5.51
Placerville	5.28
Sonora	5.42
Stirling City	6.00
Summit	5.00
Watsonville	5.20
Bear Valley	5.07
Ben Lomond	7.08
Boulder Creek	6.20
Crockers	5.12
Glenn Ranch	5.30
Glenwood	5.84
Grass Valley	5.55
Kennedy Mine	6.04
Laurel	5.65
Lowe Observatory	5.70
Lytle Creek	5.68
Mount St. Helena	5.00
January, 1907:	
Mono Ranch	5.92
Upper Mattole	8.66
February, 1907:	
Blue Canon	5.55
Branscomb	5.50
Emigrant Gap	6.00
February, 1907—Continued.	Inches.
Fort Ross	5.99
Georgetown	5.33
Stirling City	5.20
Laytonville	5.67
March, 1907:	
Blocksburg	6.02
Blue Canon	6.45
Branscomb	6.32
Brush Creek	5.70
Calistoga	5.60
Greenville	6.17
Healdsburg	5.34
Helen Mine	7.40
La Porte	7.29
Magalia	7.65
Mono Ranch	6.46
Nimshew	5.54
Quincy	6.50
Stirling City	7.90
Bear Valley	5.74
Ben Lomond	6.02
Boca	6.00
Boulder Creek	5.39
Bowmans Dam	6.49
Camptonville	5.58
Deer Creek	5.10
Fordyce Dam	5.94
Glenn Ranch	7.06
Inskip	8.00
Laurel	5.00
Laytonville	7.36
Lytle Creek	6.90
Mercury	5.40
Mount St. Helena	5.65
Upper Mattole	7.42
West Branch	7.47
Woodleaf	5.50
December, 1907:	
Branscomb	5.25
Monumental	6.70
February, 1908, Ben Lomond	5.40
March, 1908, Cisco	7.20
October, 1908, Branscomb	5.98
January, 1909:	
Ben Lomond	5.45
Blue Canon	7.20
Branscomb	8.60
Brush Creek	5.20
Camptonville	7.42
Cuyamaca	5.13
Deer Creek	8.13
Downieville	5.34
Fordyce Dam	7.53
Head Dam	6.53
Helen Mine	9.10
Inskip	6.58
Kennett	8.90
La Porte	9.16
Laytonville	6.14
Lick Observatory	6.37
Magalia	9.43
Mount St. Helena	6.65
Pilot Creek	9.16
Rialto	8.16
Santa Barbara	6.40
Sierra Madre	6.73
Summerdale	6.20
Stirling City	6.50
Upper Mattole	5.35
Upland	5.97
Woodleaf	8.00
Georgetown	6.05
Grass Valley	6.35
Angels Camp	6.97
Bear River	5.36
Glenn Ranch	6.50
Julian	6.10
Lowe Observatory	7.84
Lionsville	6.67
Lytle Creek	9.68
Mesa Grande	6.50
West Branch	7.43
Nellie	6.89

	Inches.
February, 1909:	
Cloverdale	5.38
Delta	6.89
Magalia	7.88
Mono Ranch	7.00
Santa Margarita	5.30
Sisson	7.83
Lytle Creek	5.16
March, 1909, Lytle Creek	5.52
November, 1909:	
Blue Canon	5.00
Cisco	5.05
Monumental	9.60
December, 1909:	
Rialto	6.70
Santa Margarita	7.70
Summerdale	7.62
January, 1910, Lytle Creek	5.50
January, 1911:	
Branscomb	6.85
Brush Creek	6.02
Camptonville	6.27
Los Gatos	6.15
Magalia	6.80
Nevada City	6.10
Nimshew	5.28
Santa Barbara	5.09
Squirrel Inn	5.85
Summerdale	6.43
Ben Lomond	7.15
Glenn Ranch	6.28
Glenn Ranch	6.14
Laurel	7.50
Laytonville	6.83
Lick Observatory	9.19
Lick Observatory	5.56
West Branch	5.19
March, 1911:	
Mono Ranch	7.90
San Luis Obispo	5.98
Sierra Madre	5.14
Stirling City	5.85

Mr. John Pettee states that on December 20–21, 1866, he measured the rainfall in San Francisco, as follows:

Time.	Date.	Inches.	Inches per hour.
11.30 a. m. to 4.45 p. m.	Dec. 20	1.97	0.37
4.45 p. m. to 7.45 p. m.	...do....	2.27	.76
7.45 p. m. to 9.50 p. m.	...do....	.85	.41
9.50 p. m. to 1.00 a. m.	Dec. 21	1.20	.39
1.00 a. m to 8.15 a. m.	...do....	1.47	.20
Total		7.76	.37

The reason for many measurements was that the gage held only about 2.50 inches.

MINIMUM TEMPERATURE ON MOUNT WHITNEY, CAL.

By A. G. McADIE.

Maximum and mimimum thermometers were placed in a small shelter on the north wall of the observatory on Mount Whitney, elevation 14,502 feet, in September, 1909. On May 24, 1910, Mr. G. F. Marsh, cooperative observer, succeeded in reaching the summit and found the instruments in the condition in which they were left. The minimum temperature was −23° F. and the maximum temperature 55° F.

In a Monthly Weather Review for May, 1910, the writer called attention to this reading as fairly representing the lowest temperature of that winter at the highest point in the United States proper. Lower temperatures were recorded in California during this same period. For example, −30° F. at Alturas on January 3, 1909, elevation 4,460 feet, and −29° F. at Tamarack, elevation 8,000 feet, January 5, 1909.

On September 26, 1912, the instruments were reset. Mr. F. H. Criss, who read the instruments, states that minimum thermometer No. 1270 indicated a temperature of −35° F. The maximum temperature was 65° F.

It may be stated that in the Sierra, just north of Lake Tahoe, temperatures as low as −30° F. (−34° C.) have occurred. During the winter of 1898 a minimum thermometer exposed on one of the high Sierra peaks recorded −17° F. During the same period the temperature at Bodie fell to −30° F.

The following low temperatures were reported during 1911:

	Elevation.	Temperature.	Date.
	Feet.	°F.	
Sierraville	5,000	−30	Feb. 16
Tamarack	8,000	−26	Dec. 30
Madeline	5,270	−24	Jan. 22
Truckee	5,819	−22	Feb. 26
Alturas	4,460	−21	Dec. 23

During 1912, Alturas, −26° F., January 3; Sierraville, −23° F., January 3.

BEAR VALLEY HYDROELECTRIC DEVELOPMENT, CALIFORNIA.

By JAMES H. WISE.[1]

The hydroelectric project on the south fork of the Yuba and Bear Rivers has been in contemplation for some time, but active work was not begun until permission was received from the railroad commission on July 3, 1912, by the Pacific Gas & Electric Co.

The development makes use for power purposes of the water already impounded in 20 reservoirs in the catchment area of the South Yuba, having a capacity of 2,024,000,000 cubic feet, combined with additional storage of 4,000,000,000 cubic feet, to be secured at Lake Spaulding. The water thus stored is to be diverted, together with the natural run-off, to the Bear River watershed, conducting it in tunnels and canals along the south side of the Bear River Canyon to a point about 3 miles northeast of Towle Station, on the Southern Pacific, to a regulating reservoir known as the "Drum Forebay." Two riveted steel pipe lines will lead from this reservoir to the power house, 1,350 feet lower in elevation, and situated on Bear River, where an installation of 40,000 kilowatts, consisting of 4 units, will be erected, together with the necessary transformers, exciters, governors, and other adequate equipment to make the entire installation complete. Electric power from this plant will be transmitted at 115,000 volts on a double circuit, steel-tower line, extending in a southwesterly direction via Nicolaus to Cordelia, the load center of the Pacific Gas & Electric Co. At this point stepdown transformers will be used for reducing the pressure to approximately 60,000 volts, permitting the power thus to be transmitted to various parts of the system: Oakland, Berkeley, Alameda, San Rafael, Santa Rosa, Vallejo, Petaluma, and northward toward Suisun, Cement, Woodland, Sacramento, Davis, Dixon, and, in fact, to any part of the vast territory already covered by the 60,000-volt network of transmission lines.

The project further includes the construction of a steel-tower line from Cordelia to San Rafael, Sausalito, and Lime Point, thus providing Pacific service to the Marin Peninsula and the transmission of hydroelectric power ultimately to San Francisco.

Adverting to Lake Spaulding, this splendid reservoir site, with a capacity of 4,000,000,000 cubic feet, or nearly double the combined capacity of all of the reservoirs in

[1] Assistant general manager Pacific Gas & Electric Co.